CLAIMS

What is claimed is:

1. A radar device including:

5   an antenna for receiving as reception waves radio waves coming from a plurality of external targets;

        a signal detector for converting the reception waves received by the antenna into received signals to extract quantities characterizing the received signals; and

10   a position/velocity computing unit for calculating, from the received-signal characterizing quantities extracted by the signal detector, observed position values and observed velocity values of each of the external targets; the radar device characterized by

        a target tracking filter for performing a correlation process, based

15 on first gates, on the observed position values and the observed velocity values calculated by the position/velocity computing unit, to calculate, from the observed position values and the observed velocity values that satisfy the first gates, smoothed values of the positions and velocities of each of the external targets;

20   a clustering unit for, when external targets are close to each other, creating a cluster to include the external targets, based on the smoothed values of the positions of each of the external targets; and

        an intra-cluster target tracking filter for performing a correlation process, based on second gates, on the observed position values and the

25 observed velocity values of the external targets belonging to the cluster

formed by the clustering unit, to calculate, from the observed position values and the observed velocity values that satisfy the second gates, smoothed values of the positions and velocities of each of the external targets.

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2. A radar device including:

an antenna for receiving as reception waves radio waves coming from a plurality of external targets;

a signal detector for converting the reception waves received by the antenna into received signals to extract quantities characterizing the received signals; and

a position/velocity computing unit for calculating, from the received-signal characterizing quantities extracted by the signal detector, observed position values and observed velocity values of each of the external targets; the radar device characterized by

a target tracking filter for performing a correlation process, based on first gates, on the observed position values and the observed velocity values calculated by the position/velocity computing unit, to calculate, from the observed position values and the observed velocity values that satisfy the first gates, smoothed values of the positions and velocities of each of the external targets;

a clustering unit for, when external targets are close to each other, creating a cluster to include the external targets, based on the smoothed values of the positions of each of the external targets; and

an intra-cluster target tracking filter for, while regarding the

cluster formed by the clustering unit as a single external target, calculating, from the observed position values and the observed velocity values calculated by the position/velocity computing unit, smoothed values of cluster parameters expressing features of the cluster.

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3. A radar device according to claim 2, wherein, when two external targets are present, the intra-cluster target tracking filter calculates, as the smoothed values of the cluster parameters, smoothed values of the midpoint of the external target positions, of the velocity of the midpoint, of

10   the distance between the external targets, and of the rate at which the distance varies over time.

4. A radar device according to claim 2, wherein, when three or more external targets are present, the intra-cluster target tracking filter

15   calculates, as the smoothed values of the cluster parameters, smoothed values of the weighted center of a polygon whose vertices are on the positions of the external targets, of the velocity of the weighted center, of the distances between the external targets, and of the rates at which the distances vary over time.

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5. A radar device according to claim 1 or 2, wherein, when the first gates for a plurality of external targets belonging to the cluster overlap, the intra-cluster target tracking filter performs the correlation process based on second gates created by dividing the first gates at the weighted center of

25   the external targets.

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6. A radar device according to claim 1 or 2, wherein, when the first gates for a plurality of external targets belonging to the cluster overlap, a buffer area is provided in the vicinity of the weighted center of the external targets, and the intra-cluster target tracking filter performs the correlation process based on second gates created by dividing the first gates so as to contact the outer border of the buffer area.

7. A radar device according to claim 1 or 2, wherein

the target tracking filter further calculates predicted values of the distances between the external targets; and

the clustering unit calculates the variance of the predicted values of the distances, determines a predetermined threshold based on the variance, and forms the cluster when the distances between the external targets are not larger than the threshold.

8. A radar device according to claim 1 or 2, wherein the intra-cluster target tracking filter determines, based on the distance from the weighted center of a polygon whose vertices are on the positions of the external targets, gains for determining contributions of the observed values in calculating the smoothed values.

9. A radar device according to claim 1 or 2, wherein

the antenna radiates toward the external targets a reference signal having an up phase for continuously increasing the frequency and a down

phase for continuously decreasing the frequency as transmission waves having beam patterns in a plurality of directions;

the signal detector generates, in the up phase and in the down phase, beat signals from the received signals and the reference signal; and

5   the position/velocity computing unit calculates, from the beat signals in the up phase and the beat signal in the down phase, relative velocities and relative distances of the external targets, calculates directions of the external targets from differences in quantities characterizing the beat signals in adjacent beam patterns, and calculates,

10 from the relative velocities, the relative distances, and the directions, the observed position values and the observed velocity values of the external targets.

10. A radar device according to claim 9, wherein the radar device is

15 installed in an automobile.